Evaluation of Precipitation Forecast for the COSMO Model in Reference to Z vs. Terrain Following Coordinates Version

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1 Introduction

In our previous works (Refs. [8] and [9]), it was found that the earlier Z-coordinate versions of COSMO Model (former LM) (Refs. [1] - [7]) available for testing (i.e COSMO_Z_1.4 and COSMO_Z_1.5) showed relative preponderance over the terrain-following-coordinates version (COSMO_TF_3.15) which was used at the time for operational purposes at HNMS. The comparisons were focused on the precipitation associated with modest (Ref. [8]) and strong frontal activity over Greece (Ref. [9]) for COSMO_Z_1.4 and COSMO_Z_1.5 respectively. Since then, a significant amount of work was invested towards the development of a Z-coordinate (COSMO_Z_1.9) version which incorporates the latest advances of its COSMO_TF counterpart for more consistent comparisons. In consequence, part of our previous work (Ref. [9]) is evaluated again using the new version of COSMO_Z.

2 Case Study

The frontal development during the three day period of the 17^{th}, 18^{th}, and 19^{th} of November 2005 is re-investigated within this new framework. Based on the synoptic analysis presented in Ref. [9], we proceed directly into the comparison of the results of this past work and the control experiments performed with the latest version COSMO_Z_1.9 based again on the boundary conditions from the Global Model of the German Meteorological Service (DWD) with analysis of 00 UTC for every date under consideration. In Fig. 1, we present in the right column, the 12-hour forecasted accumulated precipitation from the control experiments using COSMO_Z_1.9 against the corresponding findings from our previous work (Ref. [9]) given in the left column. The results are further organized in three four-picture panels, one for every date considered. For every one of these dates and by directly looking at the forecasts from the later COSMO_TF control runs, there is a significant overall reduction of the accumulated precipitation against the older runs based on LM_TF_3.15. The impact of this feature is also depicted to the graphs stemming from COSMO_Z_1.9 against those of COSMO_Z_1.5 runs. On a more quantitative standpoint, the observed 12-hour accumulated precipitation observations for the available meteorological stations were compared against the nearest grid point corresponding forecasted values. A rather detailed presentation regarding the status of our results is given in Table 1 where the threat scores are presented for thresholds of 1-5 mm. The threat scores (TS) are defined as follows:

$$TS = \frac{Hits}{Observations + FalseAlarms} 100 \tag{1}$$

where

$Hits$ are cases where observed and forecasted precipitation is greater or equal to a threshold value.

	November 17 57 Stations				November 18 55 Stations				November 19 55 Stations			
mm	TF_(1.9)	Z_1.9	TF_3.15	Z_1.5	TF_(1.9)	Z_1.9	TF_3.15	Z_1.5	TF_(1.9)	Z_1.9	TF_3.15	Z_1.5
1	60 27,33,12	57 24,33,9	60 27,33,12	65 28,33,10	26 5,7,12	31 5,7,9	10 4,7,33	27 6,7,15	67 36,48,6	73 37,48,3	59 32,48,6	79 42,48,5
2	62 24,30,9	65 22,30,4	57 24,30,12	62 25,30,10	20 3,5,10	21 3,5,9	6 2,5,31	28 4,5,9	62 31,45,6	57 29,45,6	54 28,45,6	67 34,45,6
3	67 22,28,5	70 21,28,2	52 21,28,12	68 24,28,7	16 2,2,10	22 2,2,7	0 0,2,29	12 1,2,6	51 24,37,10	47 21,37,8	51 23,37,8	66 29,37,7
4	67 20,26,4	74 20,26,1	52 20,16,12	75 24,26,6	20 2,2,8	14 1,2,5	0 0,2,28	17 1,2,4	56 22,30,9	40 16,30,10	51 20,30,9	60 24,30,10
5	65 19,25,4	77 20,25,1	55 19,25,9	74 23,25,6	20 2,2,8	25 1,2,2	0 0,2,27	0 0,2,4	58 19,26,7	39 14,26,10	54 19,26,9	54 20,26,11

Table 1: Threat scores (%) for observed and forecasted precipitation. Hits, observations and false Alarms are ordered below the threat score values.

	November 17 57 Stations	November 18 55 Stations	November 19 55 Stations
Observed: Total	615.4	26.0	358.1
Average	10.8	0.5	6.5
Min	0.0	0.0	0.0
Max	55.0	12.0	42.0
LM_TF(1.9): Total	657.4	94.1	574.3
Average	11.5	1.7	10.4
Min	0.0	0.0	0.0
Max	73.1	12.9	99.7
LM_Z_1.9: Total	553.6	59.5	450.2
Average	9.7	1.1	8.2
Min	0.0	0.0	0.0
Max	77.8	8.1	83.3
LM_TF_3.15: Total	1024.5	588.5	788.8
Average	18.0	10.7	14.3
Min	0.0	0.0	0.0
Max	99.4	76.8	187.6
LM_Z_1.5: Total	632.5	65.6	487.8
Average	11.1	1.2	8.9
Min	0.0	0.0	0.1
Max	76.8	8.4	44.9

Table 2: Total and average observed and forecasted precipitation height (mm)

Observations are cases where observed precipitation is greater or equal to the threshold value.

FalseAlarms are cases where the observed precipitation is smaller than the threshold value and forecasted precipitation is greater than the threshold value.

As it can also be seen from Table 2, the COSMO_TF_CONTROL runs provide a significant improvement to the total precipitation estimation against the older COSMO_TF_3.15 version and in comparison to observation while the results between COSMO_TF_CONTROL and the versions of COSMO_Z become quite comparable.

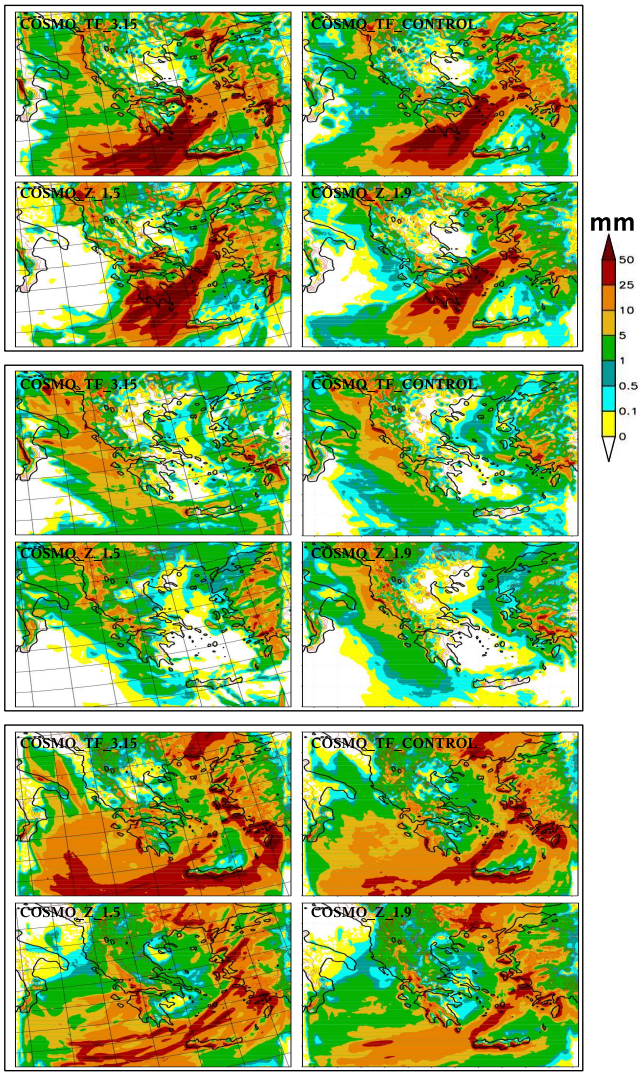

Figure 1: 12-hour (06 to 18 UTC) forecasted accumulated precipitation (mm) for 17, 18 and 19 of November 2005 in upper, middle and lower four-picture panels respectively. The initial conditions are from the Global Model of DWD based on 00 UTC analysis.

3 Summary and Outlook

In contrast to our previous works (Refs. [8] and [9]), the control runs using the latest version COSMO_Z_1.9, the preponderance of COSMO_Z against COSMO_TF is strongly reduced mainly because of the improvement that was observed in the results of COSMO_TF. However, COSMO_Z remains a fair alternative regarding precipitation.

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